Space Weather Technical Forecast

Issued on Monday, 04 September 2023 at 01:29 Local

This technical forecast provides a four day assessment of space weather events. The probabilities stated below are for reaching or exceeding the given levels. For more information about space weather impacts please see the Met Office Space Weather Scales https://www.metoffice.gov.uk/weather/learn-about/space-weather/uk-scales

Space Weather Forecast Headline: A chance of further isolated M-class flares day 1 (04 Sep). A chance of G1/Minor Storm conditions day 1 (04 Sep) reducing to a slight chance on subsequent days.

Analysis of Space Weather Activity over past 24 hours

Solar Activity: Moderate with a couple of M-class flares from the AR3413 sunspot region, peaking with a M5.9 at 03/0836UTC. This region has now rotated off the visible disc, over the northwest limb. While impossible to analyse, some magnetic looping is still visible above the region in SDO imagery. Eight sunspot regions are present on the visible disc. Although all are small and largely inactive, there has been slow development of a few regions, namely AR3420 (Cso/Beta) in the southeast and two currently unnumbered regions in the northeast (Cro/Beta and Bxo/Beta configurations).

CMEs associated with numerous flares from AR3413 in the past 24 hours are missing ahead of Earth orbit. A filament disruption that took place around 03/0500 UTC in the vicinity of AR3420 resulted in a slow, southward directed CME as has been modelled as a near miss. A filament lift-off occurred around 03/1930 UTC, again from an area close to AR3420 as well a small filament located around N20W00 around 03/2100 UTC. Further SDO imagery is required to assess if any notable CMEs have resulted from these.

Solar Wind / Geomagnetic Activity: Ongoing fast winds from CH40/+ slowly declined through the period, though likely included some limited influence from one or both of the CME arrivals that were forecast. Elevated solar winds were observed (at DSCOVR) initially with speeds of 540km/s, with solar winds generally showing a decreasing trend, falling to around 450km/s (Slightly Elevated) by the end of the period. Density was above average at first with a peak of near 33pppc by 03/0129 UTC. A fairly sudden drop to average levels was observed from 03/0815 UTC, after which only briefly above average density levels were observed. Total Interplanetary Magnetic Field (IMF), Bt, was largely Weak, generally varying between 5-8nT. A minor, but abrupt increase was observed at 03/1550 UTC, perhaps indicative of a weak CME shock. The north-south direction, Bz, was predominately negative (southward) ranging between +5 nT and -7nT. Phi angle was largely negative (towards the sun), but became positive (away from the Sun) between 03/1240-2110 UTC. Geomagnetic activity was Active to G1 Minor Storm (Kp4-5) between 03/0000-1200 UTC, since reducing to mainly Unsettled (Kp3), but with a Quiet interval from 03/1800-2100 UTC.

Energetic Particles / Solar Radiation: GOES16 high energy (greater than 10MeV) proton flux has been at background levels throughout. GOES16 high energy (greater than 2MeV) electron flux was at background to Moderate levels, with a peak of 837 pfu at 03/01450 UTC. The associated 24-hour fluence was below the Active threshold, but on an increasing trend, with 1.92e7 integrated pfu observed at 04/0000 UTC.

Four-Day Space Weather Forecast Summary

Solar Activity: A chance of further Moderate activity on day 1 (04 Sep), with isolated M-flares possible, mainly from AR3413, but then easing to mainly Low activity as this rotates further onto

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the far-side, with the other spots on the disc currently smaller and simpler.

Solar Wind / Geomagnetic Activity: Solar winds under the influence of the fast wind from CH40/+ should continue on day 1 (04 Sep) before CH42/+ likely increases speeds to Elevated once again into day 2 (05 Sep). This is one of a few fast wind influences that could occur through the period with enhanced winds continuing throughout. There is a slight chance of a glancing impact from CMEs on day 1 and 2. Mainly Unsettled to Active geomagnetic activity is expected early on day 1 (04 Sep), with a chance of G1 Minor Storm at first. Activity reducing to Quiet to Unsettled for a time, but likely increasing to Unsettled or Active again later in the UTC day or into day 2 (05 Sep), with a slight chance of G1 Minor Storm intervals. Activity through the rest of the period is likely to vary mainly between Unsettled and Active, but with a slight chance of isolated G1 Minor Storm intervals.

Energetic Particles / Solar Radiation: High energy (greater than 10 MeV) proton flux is expected to continue at normal background levels, but with a slight chance for a Minor proton storm (S1) on day 1 (04 Sep), in association with any further notable flares from AR3413 that has just rotated over the northwest limb. As this area rotates further around the far side by day 2 (05 Sep) the risk is much reduced. High energy (greater than 2 MeV) electron flux observed by GOES16 is currently at background to Moderate levels. A recent response following the easing of the solar wind pressure means that occasionally Moderate to High levels are likely on day 1 (04 Sep) ahead of the arrival of the fast wind from CH42/+. This however, is dependent on a lack of any further CME arrivals, with a slight chance of the CME from the 01 Sep arriving at GEO, that would suppress electron flux once more. With numerous high-speed stream influences in the forecast period, it should lead to periods of drop out, along with subsequent enhancements in the following days, however this detail currently remains very uncertain. The associated 24 hour fluence is expected be below the Active (1e8 integrated pfu) threshold day 1 (04 Sep), but with a chance of rising this level. Fluence should drop on days 2 and 3 (05 and 06 Sep) given increased geomagnetic activity, but may increase again on day 4 (07 Sep) if pressure on the Van Allen belts reduces.

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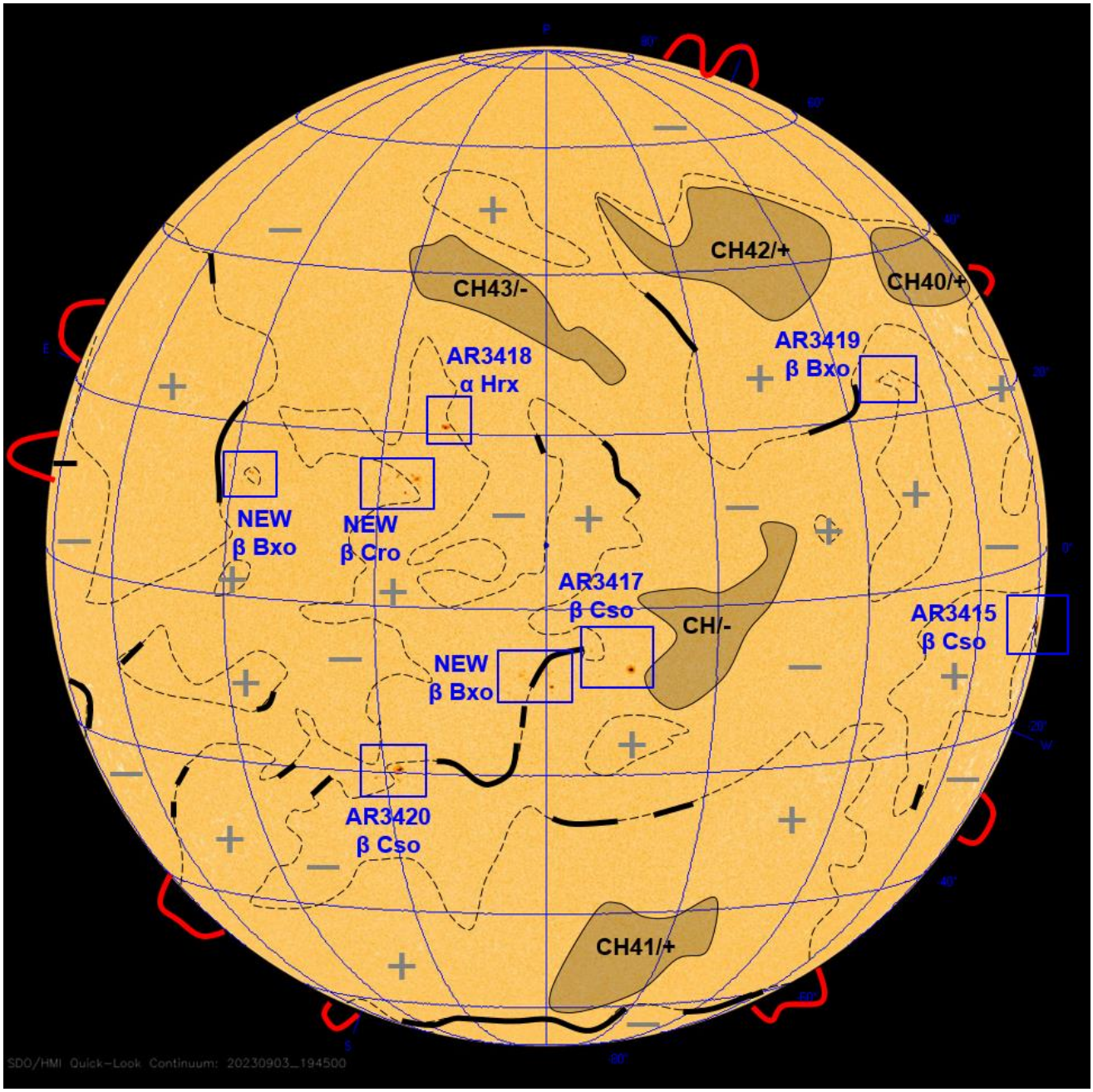
Figure 1. Solar Analysis Valid 03/1945 UTC.



Key: Filament ___ , Prominence ___ , Magnetic Field Line - - - , Polarity +/-, Coronal Holes: Grey shaded area CHxx +/-, Sunspot groups 25xx - Mt Wilson α-β-βγ-βγδ and Zurich-McIntosh Axx etc.

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Geomagnetic Storms:
Earth is currently under the weakening influence of a coronal hole high speed stream (CH40/+), as well as some residual CME effects from the past 24 hours.
A large CME that left the sun early on 01 Sep may have already glanced Earth, though there remains a slight chance of a late arrival early on day 1 (04 Sep) as indicated by Enlil. Another CME that left the sun late on 01 Sep has been analysed as missing Earth behind Earth-orbit, but with a low confidence fit to imagery and analysis, there is a slight chance of a glancing impact on day 2 (05 Sep).
CMEs associated with numerous flares from AR3413 in the past 24 hours are missing ahead of Earth orbit. A filament disruption that took place around 03/0500 UTC in the vicinity of AR3420 resulted in a slow, southward directed CME as has been modelled as a near miss. A filament lift-off occurred around 03/1930 UTC, again from an area close to AR3420 as well a small filament located around N20W00 around 03/2100 UTC. Further SDO imagery is required to assess if any notable CMEs have resulted from these.
Current Slightly Elevated winds from CH40/+ are expected to remain similar on day 1 until the expected arrival of the next the fast wind of CH42/+ during day 1 (04 Sep) and into day 2 (05 Sep), likely leading to Elevated solar winds again. These could persist throughout the period with numerous other high-speed streams moving into favourable locations to connect with Earth according to the Parker Spiral.

Mainly Unsettled to Active activity is expected early on day 1 (04 Sep), with a chance of G1 Minor Storm at first. Activity reducing to Quiet to Unsettled for a time, but likely increasing to Unsettled or Active again later in the UTC day or into day 2 (05 Sep), with a slight chance of G1 Minor Storm intervals. Activity through the rest of the period is likely to vary mainly between Unsettled and Active, but with a slight chance of isolated G1 Minor Storm intervals.

Geo-Magnetic Storm Probability (Exceedance)	Level	Past 24 Hours (Yes/No)	Day 1 (00-24 UTC) (%)	Day 2 (00-24 UTC) (%)	Day 3 (00-24 UTC) (%)	Day 4 (00-24 UTC) (%)
Minor or Moderate	G1 to G2	Yes	30	20	10	10
Strong	G3	No	1	1	1	1
Severe	G4	No	1	1	1	1
Extreme	G5	No	1	1	1	1

Geomagnetic Activity - Earthbound Coronal Mass Ejections – Nil expected

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Radio Blackouts - X-Ray Flares:
Activity is Moderate, but expected to ease to become mainly Low as AR3413, which is now over the northwest limb, continues to move away from the visible disc. This region has been the source of recent significant activity, including two M-flares in the last 24 hours. Whilst its magnetic canopy remains visible above the limb it will continue to provide a chance of activity on day 1 (04 Sep), diminishing to become nil by day 2 (05 Sep).
Eight sunspot regions are present on the visible disc. Although all are small and largely inactive, there has been slow development of a few regions, namely AR3420 (Cso/Beta) in the southeast and two currently unnumbered regions in the northeast (Cro/Beta and Bxo/Beta configurations).

X Ray Flares	Level	Past 24 Hours (Yes/No)	Day 1 (00-24 UTC)	Day 2 (00-24 UTC)	Day 3 (00-24 UTC)	Day 4 (00-24 UTC)
Probability			(%)	(%)	(%)	(%)
Active	R1-R2 M Class	Yes	25	10	10	10
Very Active	R3 to R5 X Class	No	2	1	1	1

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Solar Radiation Storms - (High Energy Protons):
The high energy (greater than 10MeV) proton flux observed by GOES-16 has now eased to background levels again after the S1 enhancement on 01 Sep. There is a slight chance for a Minor proton storm (S1) on day 1 (04 Sep) in association with any notable flares from AR3413 that has rotated over the northwest limb. This risk then recedes day 2 (05 Sep) onward with this sunspot moving further onto the far-side and with the other regions on the disc currently smaller and simpler.

Radiation Storms Probability (Exceedance)	Level (cm^{-2} sr^{-1} s^{-1})	Past 24 Hours (Yes/No)	Day 1 (00-24 UTC) (%)	Day 2 (00-24 UTC) (%)	Day 3 (00-24 UTC) (%)	Day 4 (00-24 UTC) (%)
Active	**≥ S1**	No	10	2	2	2
Very Active	**≥ S3 ***	No	1	1	1	1
* S3 ≥ 10 MeV ≥ 1000 pfu and / or ≥ 50 MeV ≥ 10 pfu. (pfu = $cm^{-2}sr^{-1}s^{-1}$)						

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High Energy Electrons Event (≥ 2MeV):

High energy (greater than 2 MeV) electron flux observed by GOES16 is currently at background to Moderate levels. A recent response following the easing of the solar wind pressure means that occasionally Moderate to High levels are likely on day 1 (04 Sep) ahead of the arrival of the fast wind from CH42/+. This however, is dependent on a lack of any further CME arrivals, with a slight chance of the CME from the 01 Sep arriving at GEO, that would suppress electron flux once more.

With numerous high-speed stream influences in the forecast period, it should lead to periods of drop out, along with subsequent enhancements in the following days, however this detail currently remains very uncertain.

The associated 24 hour fluence is expected be below the Active (1e8 integrated pfu) threshold day 1 (04 Sep), but with a chance of rising this level. MOSWOC REFM is likely to be poor, increasing fluence too quickly, as this doesn't take account of the forecast CME arrival(s).

Fluence should drop on days 2 and 3 (05 and 06 Sep) given increased geomagnetic activity, but may increase again on day 4 (07 Sep) if pressure on the Van Allen belts reduces.

GEO Electron Environment Probability (Exceedance)	Level ($cm^{-2}\,sr^{-1}\,day^{-1}$)	Past 24 Hours (Yes/No)	Day 1 (00-24 UTC) (%)	Day 2 (00-24 UTC) (%)	Day 3 (00-24 UTC) (%)	Day 4 (00-24 UTC) (%)
Active	**≥ 2 MeV ≥ $1x10^{8}$**	No	30	20	20	40
Very Active	**≥ 2 MeV ≥ $1x10^{9}$**	No	1	1	1	1

Figure 5:

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